PROCEEDINGS.

Seven hundred and thirty-second Meeting.

May 25, 1880. — ANNUAL MEETING.

The VICE-PRESIDENT in the chair.

The Treasurer and Librarian presented their annual reports.

Professor Lovering presented the following report from the Rumford Committee: —

"The mechanical theory of heat, which treats of heat as being, not a peculiar kind of matter called caloric, but as being some form or forms of molecular motion, has made necessary and possible a new branch of mechanics, under the name of thermo-dynamics. This theory has not only introduced new ideas into science, but has demanded the application, if not the invention, of special mathematical equations. Clausius has devoted thirty years to the development of thermo-dynamics, and at the end of his ninth memoir he expresses, in two brief sentences, the fundamental laws of the universe which correspond to the two fundamental theorems of the mechanical theory of heat: 1. The energy of the universe is constant; 2. The entropy of the universe tends towards a maximum.

"Professor J. Willard Gibbs, in his discussion of the 'Equilibrium of Heterogeneous Substances,' derives his criteria of equilibrium and stability from these two theorems of Clausius, and places the two generalizations of Clausius in regard to energy and entropy at the head of his first publication. Having derived from his criteria some leading equations, and having defined his sense of 'homogeneous' and its opposite, he applies these equations: —

"1. To the internal stability of homogeneous fluids.

"2. To heterogeneous masses, under the influence of gravity or

otherwise; such as gas-mixtures, solids in contact with fluids, osmotic forces, capillarity, and liquid films.

"3 Finally, he considers the modifications introduced into the conditions of equilibrium by electromotive forces.

"His treatment of the subject is severely mathematical, and incapable of being translated into common language. The formulas, however, are not barren abstractions, but have a physical meaning.

"The laws of thermo-dynamics reach down to the heart of physics and extend their roots in all directions. It is now understood that the energy of a system of bodies depends on the temperature and physical state, as well as on the forms, motions, and relative positions of these bodies. The Rumford Committee congratulate the Academy on the opportunity they now enjoy of awarding the Rumford Premium for a contribution to physical science of far-reaching importance; not anticipating, but already realizing, the approval which this award must receive from all who are conversant with the subject.

"For the Committee,

"JOSEPH LOVERING, *Chairman.*"

The report concluded with the recommendation of the following vote, which was unanimously adopted: —

"*Voted*, That the Rumford Premium, consisting of a gold and silver medal, be awarded to Professor J. Willard Gibbs for his researches in thermo-dynamics; and that the Treasurer be authorized to pay for the same from the income of the Rumford Fund."

On the motion of Professor Gray, it was

Voted, That the election of officers be postponed until the adjourned meeting.

On the motion of Professor Cooke, it was

Voted, That, when the Academy adjourn, it adjourn to the second Wednesday in June; and that the election of officers take place at that meeting.

On the motion of Professor Cooke, it was

Voted, That five hundred dollars ($500) of the unexpended balance for last year be appropriated for the publication of the forthcoming volume of Proceedings.

On the motion of Mr. Scudder, it was

Voted, That three hundred and fifty dollars ($350) from

the unexpended balance for last year be appropriated to complete the binding of books now in the hands of the binder.

The Treasurer, the Corresponding Secretary, and the Librarian were appointed a committee on appropriations for the coming year.

The following gentlemen were elected members of the Academy: —

John Rayner Edmands, of Cambridge, to be a Resident Fellow in Class I., Section 2.

Henry Purkitt Kidder, of Boston, to be a Resident Fellow in Class III., Section 3.

Marcelin Pierre Eugène Berthelot, of Paris, to be a Foreign Honorary Member in Class I., Section 3, in place of the late James Clerk Maxwell.

Seven hundred and thirty-third Meeting.

June 9, 1880. — ADJOURNED ANNUAL MEETING.

The VICE-PRESIDENT in the chair.

The death was announced of Dr. C. A. F. Peters, Director of the Kiel Observatory.

A letter was read from the Honorable Charles Francis Adams, announcing his resignation of the office of President of the Academy.

The following votes were proposed by Professor Asa Gray and unanimously adopted: —

Voted, That the Academy receives with much regret the announcement from the Honorable Charles Francis Adams that the state of his health obliges him to decline further service as President of this society.

Voted, That the Fellows of the Academy deeply regret that their distinguished President found himself unable to be present at the Centennial Celebration on the 26th ult., to deliver the historical discourse which he had prepared in compliance with the Academy's invitation; and they respectfully

solicit from Mr. Adams the manuscript of this discourse, in order that it may be published along with the addresses which were pronounced on that interesting occasion.

Voted, That the Fellows of the Academy desire to place upon record their grateful sense of the great value of their late President's services for the seven years in which he has filled the chair formerly occupied by his illustrious father and grandfather; and they proffer their best wishes for the restoration of his health in the respite from official duties which he finds it needful to seek.

On the motion of President Eliot, it was

Voted, That the thanks of the Academy be presented to the committee which made the excellent arrangements for the celebration of the Academy's hundredth anniversary on May 26th, and particularly to the Honorable Robert C. Winthrop for the very interesting and appropriate address which he delivered on the occasion, in the unexpected absence of the President.

The following report was read: —

Report of the Rumford Committee.

"Since the last annual report, Professor Rowland's elaborate investigation in relation to the mechanical equivalent of heat has been completed, and the results are printed at length in the current volume of Proceedings.

"The experiments of Mr. Holman, under the direction of Professor Cross, on the viscosity of gases, have been continued, but are not yet ready for publication.

"Other researches are in progress by members of the Committee or under their direction: those of Dr. Gibbs on measurements with the spectrometer; those of Professor Trowbridge on the heat developed by the magnetizing and demagnetizing of metals; and those of Mr. Edmands on atmospheric refraction.

"The Committee, with the consent of the Academy, took advantage of an opportunity not likely to occur again, for obtaining a copy of the standard metre of the French Government.

"They have also had the satisfaction of seeing their recommendation of the Rumford Premium to Professor J. Willard Gibbs approved by the Academy.

"They request that an appropriation of $500 be made from the income of the Rumford Fund, to enable them to continue the researches upon light and heat.

"All which is respectfully submitted.

"For the Committee,

"JOSEPH LOVERING, *Chairman.*

"JUNE 9, 1880."

In accordance with the recommendation of the Rumford Committee, it was

Voted, That an appropriation of five hundred dollars ($500) be made from the income of the Rumford Fund to enable the Rumford Committee to continue the researches upon light and heat.

On the motion of the Treasurer, it was

Voted, To appropriate, —

For publication	$1,100.00
For library	700.00
For general expenses	2,200.00

The following papers were presented by title: —

"Botanical contributions: Characters of new Genera and Species of Plants of North America and Mexico." By Asa Gray.

"On the Dimensions of the Fixed Stars, with Especial Reference to Binaries and Variables of the Algol Type." By E. C. Pickering.

1. "Furfurol, a Product of the Dry Distillation of Wood." 2. "Pyroxanthine." 3. "Mucobromic Acid and Certain of its Derivatives." By Henry B. Hill.

"Contributions from the Physical Laboratory of Harvard University." By John Trowbridge.

1. "Effect of Tension upon the Vibration of thin Membranes."
2. "Magnetic Constant of Fleitman's Nickel."
3. "Thermal Conductivity of Poor Conductors."
4. "Crooke's Phenomena in Ordinary Air."
5. "Earth Currents."

The annual election resulted in the choice of the following officers: —

JOSEPH LOVERING, *President.*
OLIVER W. HOLMES, *Vice-President.*
JOSIAH P. COOKE, *Corresponding Secretary.*
JOHN TROWBRIDGE, *Recording Secretary.*
THEODORE LYMAN, *Treasurer.*
SAMUEL H. SCUDDER, *Librarian.*

Council.

JAMES M. PEIRCE,
JOHN M. ORDWAY,
WOLCOTT GIBBS, } of Class I.

ALEXANDER AGASSIZ,
HENRY W. WILLIAMS,
GEORGE L. GOODALE, } of Class II.

ROBERT C. WINTHROP,
CHARLES G. LORING,
FRANCIS J. CHILD, } of Class III.

Rumford Committee.

WOLCOTT GIBBS, JOHN TROWBRIDGE,
EDWARD C. PICKERING, JOSIAH P. COOKE,
JOHN M. ORDWAY, JOSEPH LOVERING,
GEORGE B. CLARK.

Member of Finance Committee.

THOMAS T. BOUVÉ.

The following committees were appointed by the President: —

Committee on Publication.

JOSIAH P. COOKE, ALEXANDER AGASSIZ,
JOHN TROWBRIDGE.

Committee on Library.

EDWARD C. PICKERING, HENRY P. BOWDITCH,
WILLIAM R. NICHOLS.

Auditing Committee.

HENRY G. DENNY, ROBERT W. HOOPER.

Seven hundred and thirty-fourth Meeting.

October 13, 1880. — STATED MEETING.

The PRESIDENT in the chair.

The President announced the death of Professor Haldeman, Count Pourtalès, Dr. C. T. Jackson, and Professor Benjamin Peirce.

The Corresponding Secretary announced that letters had been received from Mrs. Miller, announcing the death of Professor William Hallowes Miller; M. Berthelot, acknowledging election as Foreign Honorary Member; and Mr. Theodore Lyman, announcing the death of Count Louis François de Pourtalès.

The following gentlemen were elected members of the Academy: —

Henry Williamson Haynes, of Boston, to be a Resident Fellow in Class III., Section 2.

Arthur Auwers, of Berlin, to be a Foreign Honorary Member in Class I., Section 2, in place of the late Christian August Friedrich Peters.

Alfred Louis Olivier Legrand des Cloizeaux, of Paris, to be a Foreign Honorary Member in Class II., Section 1, in place of the late William Hallowes Miller.

Professor Pickering presented, by title, the following papers: —

"Determination of the Greatest Height, consistent with Stability, that a Vertical Pole or Mast can be carried, and of the Greatest Height to which a Tree can Grow." By A. G. Greenhill.

"Theory of the Constitution of the Sun, founded upon Spectroscopic Observations, original and other." By Charles S. Hastings.

Mr. S. H. Scudder exhibited a remarkable fossil insect. Remarks upon this subject were made by Professor Morse.

Seven hundred and thirty-fifth Meeting.

November 10, 1880. — MONTHLY MEETING.

The PRESIDENT in the chair.

The President, in the absence of the Corresponding Secretary, read letters from Mr. Henry W. Haynes, accepting fellowship in the Academy, and the Honorable Charles Francis Adams, relative to the address which he prepared for the recent centennial of the Academy.

The following papers were presented: —

"On the Nomenclature of various Manifestations of Energy." By A. E. Dolbear.

"On an Acoustic Phenomenon noticed in a Crooke's Tube." By Charles R. Cross.

Professor Dolbear spoke of a possible means of protection from lightning.

Seven hundred and thirty-sixth Meeting.

December 8, 1880. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from Messrs. Auwers and Des Cloizeaux, acknowledging election as Foreign Honorary Members; M. Daguin, presenting a copy of the fourth edition of his *Traité de Physique;* and C. N. Racotta, President, announcing the formation of the "Société d'Agriculture Roumaine," at Bucharest, and proposing an exchange of publications with the Academy.

The following papers were presented: —

"Superficial Tension at Low Temperatures." By N. D. C. Hodges.

"Palæozoic Myriapods as Types of a New Order." By S. H. Scudder.

"Relation between the Imperial Yard, Bronze No. 1, and the Metre of the Archives." By W. A. Rogers.

"On the Conditions for Accuracy in Measuring the Angle between two Reflecting Surfaces." By J. Rayner Edmands.

The Recording Secretary read the following paper: —

"On the Distribution of Heat in the Diffraction Spectrum." By S. P. Langley.

Remarks on this paper were made by Professors Cooke and Dolbear.

The following papers were presented by title: —

"On Chlorbromacrylic Acids and Diiodbromacrylic Acid." By C. F. Mabery and Rachel Lloyd.

"Memoir on Phosphorescence." By John W. Draper.

Professor Dolbear read the following papers: —

"On the Physical Theory of Gravitation."

"On the Amplitude of Atomic Motions."

Seven hundred and thirty-seventh Meeting.

January 12, 1881. — STATED MEETING.

The Academy met at the house of Mr. Henry P. Kidder, 2 Newbury Street, Boston.

The President opened the meeting with the following address: —

"In a letter, dated July 12, 1796, addressed to the Hon. John Adams, then President of the Academy, Count Rumford gave notice of the trust which he had committed to their administration. Since 1797, when the funds indicated in this letter were received, the Academy has not failed in earnest endeavors to comply with the conditions of the trust. At the annual meeting of 1799, it was voted that the

terms on which the Rumford Premium, thus instituted, might be awarded should be published in the newspapers of the Capitals of the different States and of some of the American Islands. At the annual meeting of 1801 it was voted, that the Academy, at their meeting in May next, and afterwards biennially, will decide on the discovery or improvement which may appear to be entitled to the premium contemplated by Count Rumford, according to the terms of his letter of July 12, 1796. In 1802, a committee of the Academy reported that no discovery or improvement worthy of the premium, and fulfilling the required conditions, had come to their knowledge. In 1804, a claim was presented which did not receive the approval of the Academy. In 1805, it was voted that the terms on which the premium might be awarded should be published annually. In 1806, two more unsuccessful claims were presented. In 1809, a committee consisting of Judge John Davis, the Hon. John Quincy Adams, with the Recording Secretary, was appointed to consider generally the question of the Rumford Premium. In 1811, it was voted that the Secretary should publish a description of the Rumford Trust. In 1816, it was again voted that the conditions attached to the premium should be published annually. Another vote to the same effect was passed in 1820. In 1824, several applications were referred to a committee, and were probably included in the five applications rejected in 1830.

"It thus appears that the failure of the Academy to make any award, during this long period, cannot be charged to any lack of interest or attention on the part of our predecessors. It was partly due to the low state of some branches of physical science at that time; but also, in part, to some of the conditions under which the trust had been given and received. In consequence of a long report upon the subject made to the Academy in 1829, by a distinguished committee, consisting of Nathaniel Bowditch, Josiah Quincy, and Francis C. Gray, relief in the matter of the Rumford Fund was sought in 1831, and obtained in 1832, from the Supreme Court of Massachusetts. With the greater freedom of administration thus acquired, the Academy has been able to award the Rumford Premium nine times, eight of which have occurred since 1861, as follows: —

"1. To Robert Hare, for the Compound Blowpipe.

"2. To John B. Ericsson, for Improvements in the Caloric Engine.

"3. To Daniel Treadwell, for Improvements in the Construction of Cannon.

"4. To Alvan Clark, for Improvements in Achromatic Telescopes.

"5. To George H. Corliss, for Improvements in the Steam-engine.

"6. To Joseph Harrison, Jr., for his Method of constructing Steam-boilers.

"7. To L. M. Rutherford, for Improvements in Astronomical Photography.

"8. To John W. Draper, for his Researches on Radiant Energy.

"9. To J. Willard Gibbs, for his Researches in Thermo-dynamics.

"The medals which were awarded to Professor J. Willard Gibbs at the last annual meeting of the Academy, have been prepared under the direction of the Rumford Committee, and are now ready for presentation.

"Rumford lived at a time when the machinery of science was largely composed of supernumerary fluids, interpenetrating or superimposed upon ordinary matter. Newton had indeed banished from mechanical astronomy the celebrated vortices of Descartes; but Franklin and others had introduced a fresh supply of hypothetical fluids into the sciences of electricity, magnetism, and heat. Many of us are old enough to have witnessed a great and pregnant revolution in thermotics; when the theory that heat is a mode of motion supplanted the old view that heat is an impalpable substance, — the caloric, that is, of Rumford's day. Since the establishment of the new view, many anticipations of it, which produced no impression upon science at the time, have been rescued from oblivion. In a lecture read in the chapel of Harvard College, on Nov. 26, 1755, on occasion of the great earthquake which shook New England the week before, Professor John Winthrop said: 'There seems to be an inexhaustible source of this heat in the attractive powers which Sir Isaac Newton has shown to belong to the particles of matter; for heat, consisting of a peculiar intestine motion of the parts of bodies, whatever tends to produce this motion in bodies will cause them to grow hot. Now such a motion may be produced by the particles of different bodies rushing together in virtue of their attractive powers.' The philosopher Locke held the same view, and expressed it elegantly, thus: 'What in our sensation is *heat*, in the object is nothing but motion.' Bacon's definition of heat antedates all this, and is no less explicit. His words are: 'When I say of motion that it is the genus of which heat is a species, I would be understood to mean, not that heat generates motion, or that motion generates heat (though both are true in certain cases), but that heat itself, its essence and quiddity, is motion, and nothing else. . . .'

"But all these preconceived suggestions of the reasoning faculty are,

in a scientific point of view, overshadowed by the grand experiment of Rumford, made at Munich in 1798, when, in the process of boring cannon, he converted, by the agency of what has been vaguely called friction, mechanical power into heat, and on a scale sufficient to boil two and one half gallons of water; and saw, with his clear, scientific vision, that nothing could have been excited or communicated by this operation but some kind of motion. Less dazzling, but no less conclusive, was Davy's later experiment of melting ice by rubbing. But the views of Rumford were in advance of the general scientific thought of his day by more than a generation, and were finally forced upon science by the long and masterly series of experiments made by Joule. The rude data supplied by Rumford's experiment gave, in the hands of Joule, an approximate value to the mechanical equivalent of heat; but our knowledge of the precise rate of exchange in the mutual conversion of heat and power rests upon the repeated, varied, and elaborate experiments of Joule himself. I will now let Mr. Tyndall speak for Rumford. 'When,' he says, 'the history of the dynamical theory of heat is written, the man who, in opposition to the scientific belief of his time, could experiment, and reason upon experiment, as Rumford did, . . . cannot be lightly passed over. Hardly anything more powerful against the materiality of heat has been since adduced; hardly anything more conclusive in the way of establishing that heat is, what Rumford considered it to be, Motion.'

"On the mechanical theory of heat, as a foundation, has been erected the grandest generalization of physical science, the Conservation of Energy. The results of observation and calculation agree, whenever a comparison is practicable, if the calculation is made upon the assumption that the totality of energy in a system, potential as well as dynamical, is as unchangeable as the totality of matter. This sweeping generalization includes and interprets Grove's experimental demonstration of the correlation and convertibility of the different forms of energy, known under the familiar names of gravity, elasticity, light, heat, electricity, magnetism, and chemical affinities. The conversion of heat (which is supplied to an indefinite amount by the consumption of the forests and the coal-beds) into ordinary mechanical energy or work, is of the highest significance to the advancing civilization of the race; but heat cannot be transformed into work without the transformation of a larger amount of heat of high temperature into heat of low temperature. This passage of heat from hot to cold bodies, without doing work, reinforced by the conduction and radiation of heat, creates the tendency to what is now called the dissipation of heat. This is what

the writer in the *London Spectator* meant when he called heat the communist of the universe, the final consummation of this dissipation being a second chaos. Sir William Thomson has computed that the sun has lost through its radiations hundreds of times as much mechanical energy as is represented by the motions of all the planets. The energy thus dispensed to the solar system, and from it to remoter space, 'is dissipated, always more and more widely, through endless space, and never has been, and probably never can be, restored to the sun without acts as much beyond the scope of human intelligence as a creation or annihilation of energy, or of matter itself, would be.' Therefore, unless the sun has foreign supplies, in the fall of meteors or otherwise, where its drafts will be honored, its days are numbered.

"What I have attempted to state in language as little technical as possible is tersely expressed by Clausius in two short sentences: 'The energy of the world is constant.' 'The entropy of the world (that is, the energy not available for work) tends constantly towards a maximum.'

"Professor J. Willard Gibbs takes his departure from these two propositions when he enters upon his investigation on the 'Equilibrium of Heterogeneous Substances.' Any adequate theoretical treatment of this complex subject must be, necessarily, highly mathematical, and intelligible only to those familiar with the analytical theory of heat. To assist the imagination, Professor Gibbs has devised various geometrical constructions; especially one, of a curved surface, in which each point represents, through its three rectangular coördinates, the volume, energy, and entropy of a body in one of its momentary conditions. The late Professor J. C. Maxwell (whose early death is ever a fresh grief to science) devoted thirteen pages of the fourth edition of his 'Treatise on Heat' to the elucidation and application of these constructions; and it is understood that he embodied in a visible model the equations in which Professor Gibbs expressed his strange surface. In a lecture delivered before the Chemical Society of London, Professor Maxwell gave publicly the endorsement of his great name to the merits of these researches which we are now met to honor. He says: 'I must not, however, omit to mention a most important American contribution to this part of thermodynamics by Professor Willard Gibbs, of Yale College, U. S., who has given us a remarkably simple and thoroughly satisfactory method of representing the relations of the different states of matter, by means of a model. By means of this model, problems which had long resisted the efforts of myself and others may be solved at once.'

"It is now my pleasant duty to present, in the name of the Academy and with their approving voice, the gold and silver medals to the Recording Secretary, Professor Trowbridge, who has been commissioned by Professor Gibbs to represent him on this occasion. I cannot but think that if Count Rumford were living, he would regard with peculiar pleasure this award. For the researches of Professor Gibbs are the consummate flower and fruit of seeds planted by Rumford himself, though in an unpromising soil, almost a century ago. In transmitting these medals to Professor Gibbs, by which the Academy desires to honor and to crown his profound scientific work, be pleased to assure him of my warm congratulations and of the felicitations of all the Fellows of the Academy, here assembled to administer Count Rumford's Trust."

In reply to the President's address, the Recording Secretary then read the following letter from Professor Gibbs: —

"To the American Academy of Arts and Sciences: —

"*Gentlemen*, — Regretting that I am unable to be present at the meeting to which I have been invited by your President, I desire to express my appreciation of the very distinguished honor which you have thought fit to confer upon me. This mark of approbation of my treatment of questions in thermo-dynamics is the more gratifying, as the value of theoretical investigation is more difficult to estimate than the results obtained in other fields of labor. One of the principal objects of theoretical research in any department of knowledge is to find the point of view from which the subject appears in its greatest simplicity. The success of the investigation in this respect is a matter which he who makes them may be least able to form a correct judgment. It is, therefore, an especial satisfaction to find one's methods approved by competent judges.

"The leading idea which I followed in my paper on the Equilibrium of Heterogeneous Substances was to develop the *rôles* of energy and entropy in the theory of thermo-dynamic equilibrium. By means of these quantities the general condition of equilibrium is easily expressed, and by applying this to various cases we are led at once to the special conditions which characterize them. We thus obtain the consequences resulting from the fundamental principles of thermo-dynamics (which are implied in the definitions of energy and entropy) by a process which seems more simple, and which lends itself more readily to the solution of problems, than the usual method, in which the several parts

of a cyclic operation are explicitly and separately considered. Although my results were in a large measure such as had previously been demonstrated by other methods, yet, as I readily obtained those which were to me before unknown, or but vaguely known, I was confirmed in my belief in the suitableness of the method adopted.

"A distinguished German physicist has said, — if my memory serves me aright, — that it is the office of theoretical investigation to give the form in which the results of experiment may be expressed. In the present case we are led to certain functions which play the principal part in determining the behavior of matter in respect to chemical equilibrium. The forms of these functions, however, remain to be determined by experiment, and here we meet the greatest difficulties, and find an inexhaustible field of labor. In most cases, probably, we must content ourselves at first with finding out what we can about these functions without expecting to arrive immediately at complete expressions of them. Only in the simplest case, that of gases, have I been able to write the equation expressing such a function for a body of variable composition, and here the equation only holds with a degree of approximation corresponding to the approach of the gas to the state which we call perfect.

"Gratefully acknowledging the very favorable view which you have taken of my efforts, I remain, gentlemen, very truly yours,

"J. Willard Gibbs.

"New Haven, Jan. 10, 1881."

The following papers were presented: —

"Discovery of Palæolithic Flint Implements in Upper Egypt." By Henry W. Haynes.

"On Telegraphing across Bodies of Water without the Use of a Cable." By John Trowbridge.

"Anticipation of the Lissajous Curves." By Joseph Lovering.

Dr. William Everett presented the following suggested emendation of Shakespeare: —

"Hamlet, Act I. Sc. 4.

"'The dram of eale
Doth all the noble substance of a doubt
To his own scandal.'

"Every reader of Shakespeare has been puzzled by these words; and every critical student of him knows that they are the *crux* of

textual criticism. Many excellent editors, like R. G. White, leave them as above. The fact that the folio omits them, and that we have only quarto authority for their existence, does not help us. Still, something has been done, and one or two points may be accepted as proved; and as such they will be assumed here. 1st. The word *eale* is a strange misprint for some word denoting *harm;* as, *bad*, *bale*, *base*, *evil*, or *ill.* 2d. *Of* contains the elements of *oft.* 3d. The words *a doubt* contain a verb to which *doth* is the auxiliary; and *dram* and *substance* supply the subject and object.

"Hence have resulted a variety of conjectural emendations, all more or less plausible as far as their resemblance in letters goes. The general sense of them is the same, and is that of the following, which I give, not as a *possible reading*, but as a kind of paraphrase of what all emendations convey: —

> The dram of *wrong*
> Doth all the noble substance oft *infect*
> To his own scandal;

making *dram* the subject and *substance* the object.

"Now it seems to me that all emendations in this direction miss the fact that it is *the noble substance* that suffers scandal. The *dram of corruption* can get no *scandal;* yet in this thought it is the agent — the subject — that does something to its *own scandal;* for *own* cannot be used of the object or thing acted on. This is purely a grammatical necessity independently of the sense, and will be seen by putting *X* and *Y* for *the dram* and *the substance.*

"Therefore, to give *own* its proper force, it must refer to the subject of *doth* [*Y*], that is, *the noble substance* is the subject, *the dram of* [*X*] must be the object, and the missing verb must be one properly expressing what *a noble nature* does to *a small element of corruption.*

"I do not pretend to decide on the proper reading for *eale.* I am inclined to prefer *ill;* but as far as the verb goes, I feel little doubt.

"Read,

> This dram of ill (?)
> Doth all the noble substance *oft adopt*
> To his own scandal.

"If *adopt* were read off to some Holofernes of the printing-office who refused to say '*dout*, fine, when he should pronounce *doubt*,' we have the beginnings of the *textus receptus* at once."

The following paper was presented by title: —

"On the Use of the Electric Telegraph during Total Solar Eclipses." By D. P. Todd.

On the motion of Professor Cooke, it was

Voted, To adjourn this meeting to the second Wednesday in February.

Seven hundred and thirty-eighth Meeting.

February 9, 1881. — ADJOURNED STATED MEETING.

The PRESIDENT in the chair.

Professor Lovering read a report from the Rumford Committee. In accordance with the recommendation of the committee, it was

Voted, To appropriate four hundred dollars ($400) for the purchase of books on light and heat, at the discretion of Mr. Scudder; also,

Voted, That three hundred dollars ($300) be appropriated to Professor S. P. Langley, for experiments on the distribution of heat in the diffraction spectrum.

The following papers were presented: —

"Observations on the Senses of Sight and Touch." By Henry P. Bowditch.

"Thermo-dynamic Basis of the Kinetic Theory of Gases." By N. D. C. Hodges.

"Strength and Stiffness of small Spruce Beams." By F. E. Kidder; presented by Professor Cross.

"Variable Stars of Short Period." By Edward C. Pickering.

"On the Propagation of Magnetic Waves in Soft Iron." By Harold Whiting; presented by Professor Trowbridge.

"Observations on the Zodiacal Light." By Arthur Searle.

"Curcumine." By C. Loring Jackson.

Charles Edouard Brown-Séquard, of Paris, was elected a Foreign Honorary Member in Class II., Section 4.

Seven hundred and thirty-ninth Meeting.

March 9, 1881. — STATED MEETING.

The PRESIDENT in the chair.

The President announced the death of Mr. George B. Emerson, the Senior Fellow of the Academy.

The following papers were presented by title: —

"General Properties of certain Partial Differential Equations similar to those of Hydrodynamics." By Thomas Craig.

"Observations on Jupiter." By Leopold Trouvelot.

Professor Cooke presented a bound volume of chemical contributions from the laboratory of Harvard College.

Seven hundred and fortieth Meeting.

April 13, 1881. — MONTHLY MEETING.

The PRESIDENT in the chair.

The President called attention to the copies of the first part of Volume XVI. of the Proceedings on the Table, which were ready for distribution.

The following papers were presented: —

"On large Telescopes." By E. C. Pickering.

"An Illustration of the Lines of Weakness in Cylinders." By Robert H. Richards.

"On the Possible Causes of some Phenomena described under the General Name of Zodiacal Light." By Arthur Searle.

"Studies in Metrology." First article. By William A. Rogers.

The following papers were presented by title: —

"Photometric Measurements made at the Harvard College Observatory of the Variable Stars β Persei and DM. 81°25." By Edward C. Pickering.

"On Osmyl Ditetramine." By Wolcott Gibbs.

Seven hundred and forty-first Meeting.

May 11, 1881. — MONTHLY MEETING.

The PRESIDENT in the chair.

Mr. Arthur Searle presented a communication on the zodiacal light.

Professor Josiah P. Cooke made some remarks on Prout's Law, and presented the following papers by students in the Chemical Laboratory of Harvard College: —

"On the Atomic Weight of Copper." By G. M. Hyams.

"On the Atomic Weight of Cadmium." By O. W. Huntington.